

BAKER (MICHAEL) JR INC BEAVER PA

NATIONAL DAM SAFETY PROGRAM, GAINES MILL DAM (INVENTORY NUMBER --ETC(U)

DACW65-80-D-0032

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JAMES RIVER BASIN

LEVEL

Name of Dam: Gaines Mill Dam

Location: Hanover County, State of Virginia

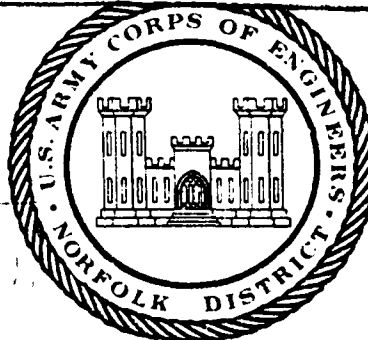
Inventory Number: VA 08506 ✓

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# PHASE I INSPECTION REPORT

## NATIONAL DAM SAFETY PROGRAM

Gaines Mill Dam (Inventory Number VA 08506)  
James River Basin, Hanover County, Virginia.  
Phase I Inspection Report.



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PREPARED FOR  
NORFOLK DISTRICT CORPS OF ENGINEERS  
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## 20. Abstract

Pursuant to Public Law 92-367, Phase I Inspection Reports are prepared under guidance contained in the recommended guidelines for safety inspection of dams, published by the Office of Chief of Engineers, Washington, D. C. 20314. The purpose of a Phase I Inspection is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general conditions of the dam is based upon available data and visual inspection. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

Based upon the field conditions at the time of the field inspection and all available engineering data, the Phase I report addresses the hydraulic, hydrologic, geologic, geotechnic, and structural aspects of the dam. The engineering techniques employed give a reasonably accurate assessment of the conditions of the dam. It should be realized that certain engineering aspects cannot be fully analyzed during a Phase I inspection. Assessment and remedial measures in the report include the requirements of additional indepth study when necessary.

Phase I reports include project information of the dam appurtenances, all existing engineering data, operational procedures, hydraulic/hydrologic data of the watershed, dam stability, visual inspection report and an assessment including required remedial measures.

## PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of the Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (flood discharges that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the design flood should not be interpreted as necessarily posing a highly inadequate condition. The design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition, and the downstream damage potential.

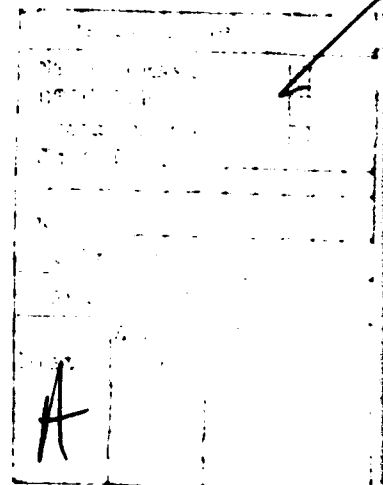
PHASE I INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM

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NAME OF DAM: GAINES MILL DAM

PHASE I INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM

Name of Dam: Gaines Mill Dam  
State: Commonwealth of Virginia  
County: Hanover  
USGS 7.5 Minute Quadrangle: Seven Pines, VA  
Stream: Powhite Creek  
Date of Inspection: 16 January 1981

BRIEF ASSESSMENT OF DAM

Gaines Mill Dam is an earthfill embankment 14.2 feet high<sup>1</sup> and approximately 305 feet long. The dam, located in Hanover County, Virginia, is used to impound water for recreational purposes. The dam is owned by Mr. O. T. Hanson of Highland Spring, Virginia and Mrs. J. T. Sichol of Richmond, Virginia. Gaines Mill Dam is a "small" size - "high" hazard dam as defined by the Recommended Guidelines for Safety Inspection of Dams. The dam and appurtenant structures were in good condition at the time of the inspection. Signs of instability were not observed and a stability check of the dam is not required.

The spillway is a concrete broad-crested weir, 25.8 feet long, with the elevation of the crest 2.2 feet below the minimum top of dam and located adjacent to the right abutment.<sup>2</sup>

Using the Corps of Engineers' screening criteria for initial review of spillway adequacy, the 1/2 Probable Maximum Flood (1/2 PMF) was selected as the spillway design flood (SDF). The spillway is capable of passing up to 14 percent of the SDF or 7 percent of the PMF without overtopping the dam. Overtopping flows are considered to be detrimental to the embankment. Therefore, the spillway is adjudged as seriously inadequate since dam failure from overtopping would significantly increase the hazard to loss of life downstream from the dam over that which would exist just before overtopping failure. ←

Due to the seriously inadequate spillway, the dam is assessed as unsafe, non-emergency. The classification of "unsafe"

<sup>1</sup>Measured from the streambed at the downstream toe to the minimum top of dam.

<sup>2</sup>Facing downstream.

NAME OF DAM: GAINES MILL DAM

applied to a dam because of a seriously inadequate spillway is not meant to connote the same degree of emergency as would be associated with an unsafe classification applied for a structural deficiency. It does mean, however, based on an initial screening and preliminary computations, that there appears to be a serious deficiency in spillway capacity. If a severe storm were to occur, overtopping and failure of the dam would take place, significantly increasing the hazard to loss of life downstream from the dam.

It is recommended that, within two months of the date of notification of the Governor of the Commonwealth of Virginia, the owner engage the services of a professional engineering consultant to perform a detailed hydrologic/hydraulic study to evaluate spillway capacity.

Within six months of the notification of the Governor, the consultant's report of appropriate remedial measures should have been completed and the owner should have an agreement with the Commonwealth of Virginia for a reasonable time frame in which all remedial measures will be complete.

Visual inspection and office analyses indicate deficiencies requiring remedial treatment.

The seep area on the downstream slope and the wet and ponded areas near the toe of the embankment should be examined at regular intervals and after periods of heavy rain for any signs of increased flow or turbidity. If increased flow or turbidity is noted, a qualified geotechnical engineering firm should be retained to perform a stability check of the dam.

The condition of the concrete in the spillway and the erosion at the toe of the spillway and in the discharge channel should be closely monitored. These items are currently assessed as having no detrimental effect on the dam, but should conditions change in the future, remedial measures may become necessary.

Regular inspections should be made of the dam and appurtenant structures. A thorough check list should be compiled for use by the owner's representative as a guide for the inspections. Maintenance items should be completed annually.

A formal warning system and emergency action plan should be developed and put into effect as soon as possible.

NAME OF DAM: GAINES MILL DAM

The following repair items should be accomplished as part of the general maintenance of the dam:


- 1) Cut brush and trees on the embankment at ground level and remove the root systems of trees with a trunk diameter greater than 3 inches. The resultant holes should then be backfilled, compacted and seeded.
- 2) On the upstream face, backfill, compact, and seed the two eroded areas left of the spillway.
- 3) On the downstream face, backfill, compact, and seed the gully across the right side of the slope to the discharge channel, and the soggy areas and ponded areas near the toe of the embankment.
- 4) Repair the eroded concrete on the spillway retaining walls.
- 5) Clear the discharge channel of sediment, fallen trees and other debris.
- 6) Install a staff gage to monitor reservoir levels above normal pool.

MICHAEL BAKER, JR., INC.

SUBMITTED:

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JAMES A. WALSH

James A. Walsh, P.E.  
Chief, Design Branch

  
Michael Baker, III, P.E.  
Chairman of the Board and  
Chief Executive Officer

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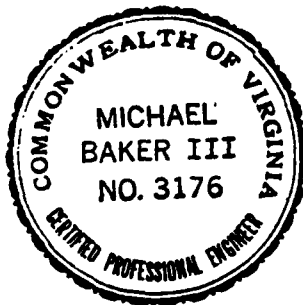
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Chief, Engineering

APPROVED:

Original signed by:  
Douglas L. Haller

Douglas L. Haller  
Colonel, Corps of Engineers  
District Engineer



Date:

APR 27 1981

NAME OF DAM: GAINES MILL DAM



OVERALL VIEW OF DAM

PHASE I INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM  
NAME OF DAM: GAINES MILL DAM ID# VA 08506

SECTION 1 - PROJECT INFORMATION

1.1 General

- 1.1.1 Authority: Public Law 92-367, 8 August 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of safety inspections of dams throughout the United States. The Norfolk District has been assigned the responsibility of supervising the inspection of dams in the Commonwealth of Virginia.
- 1.1.2 Purpose of Inspection: The purpose is to conduct a Phase I inspection according to the Recommended Guidelines for Safety Inspection of Dams (Reference 12, Appendix IV). The main responsibility is to expeditiously identify those dams which may be a potential hazard to human life or property.

1.2 Description of Project

- 1.2.1 Description of Dam and Appurtenances: Gaines Mill Dam is an earth embankment 14.2 feet high<sup>1</sup> and approximately 305 feet long. The upstream embankment slope is 2.5H:1V (Horizontal to Vertical) and the downstream embankment slope varies from 1.9H:1V to 1.4H:1V. The average width of the crest is 12 feet, with a minimum width of 10 feet. The minimum top of dam, as determined from the field investigation, is at elevation 1002.2 feet Temporary Bench Mark (T.B.M.).<sup>2</sup> There is no information available on a cutoff trench or

<sup>1</sup>Measured from the streambed at the downstream toe of the dam to the minimum top of dam.

<sup>2</sup>All elevations are referenced to a Temporary Bench Mark located on the spillway crest at the extreme left side of the spillway, facing downstream. The assumed elevation of this point is 1000.0 feet.

NAME OF DAM: GAINES MILL DAM

zoning of embankment materials. No evidence of an internal drainage system or slope protection for the dam was found.

The spillway, adjacent to the right<sup>3</sup> side of the embankment, is 25.8 feet long and consists of a cast-in-place concrete weir with retaining walls (Photo 1). The weir has a 2 foot wide level crest at an elevation of 1000.0 feet T.B.M. and a downstream face which slopes at about 45° to an elevation of 995.7 feet T.B.M. The concrete retaining walls which border the weir extend 8 feet downstream from the spillway crest and 0.6 feet and 0.3 feet above the crest on the left and right sides, respectively. A wooden footbridge runs along the spillway crest 1.2 feet above the crest elevation. The discharge channel is approximately 5 feet deep, 15 feet wide and 150 feet long. It extends from the spillway to a shallow pool downstream from the center of the embankment (Photo 2). From this pool, Powhite Creek continues downstream approximately 2.1 miles to its mouth at the Chickahominy River.

The reservoir is fed by runoff from the Powhite Creek watershed to the northeast and from the watershed of an unnamed creek to the northwest. The watershed above the dam is comprised of about half woodlands and half farmlands.

1.2.2      Location: Gaines Mill Dam is located in Hanover County, Virginia, approximately 10 miles northeast of Richmond and 4 miles southeast of Mechanicsville. The dam is constructed on Powhite Creek, approximately 500 feet upstream of the VA Route 156 bridge over Powhite Creek. A Location Plan is included in Appendix I of this report.

1.2.3      Size Classification: The height of Gaines Mill Dam is 14.2 feet and the reservoir storage capacity at the minimum crest of the dam (elevation 1002.2 feet T.B.M.) is 109

<sup>3</sup>Facing downstream.

NAME OF DAM: GAINES MILL DAM

acre-feet. Therefore, the dam is in the "small" size category as defined by the Recommended Guidelines for Safety Inspection of Dams.

- 1.2.4 Hazard Classification: The original mill, located about 300 feet downstream of the dam, has been rebuilt and converted to a residence. Approximately 500 feet downstream of the dam, Powhite Creek is conveyed beneath VA Route 156 by two concrete box culverts, each 5.5 feet high and 10.0 feet wide (Photo 4). The road above these culverts is approximately 2 feet higher than the crest of the dam. No additional development is located near the creek from the VA Route 156 bridge downstream to the Chickahominy River. In the event of a dam failure, loss of life at the "mill" house and damage to both the house and VA Route 156 are considered possible. Gaines Mill Dam is therefore considered in the "high" hazard category as defined by the Recommended Guidelines for Safety Inspection of Dams. The hazard classification used to categorize dams is a function of location only and is not related to its stability or probability of failure.
- 1.2.5 Ownership: The dam is owned by Mr. O. T. Hanson, P.O. Box 160, Highland Spring, Virginia 23075 and Mrs. J. T. Sichol, Pine Shop, 207 West Nine Mile Road, Richmond, Virginia 23223.
- 1.2.6 Purpose: The dam is used for recreational purposes.
- 1.2.7 Design and Construction History: The dam was originally built before the Civil War around 1850. The dam was intentionally breached and rebuilt in 1926. No other information on the design and construction history of the dam was available.

NAME OF DAM: GAINES MILL DAM

- 1.2.8 Normal Operating Procedures: The reservoir is normally maintained at the crest of the control section of the spillway at elevation 1000.0 feet T.B.M. No formal operating procedures are followed for this structure.

1.3 Pertinent Data

- 1.3.1 Drainage Area: The drainage area tributary to the dam is 2.69 square miles.
- 1.3.2 Discharge at Dam Site: The maximum discharge from the reservoir is unknown. With the pool level at the minimum top of dam, the spillway is capable of passing a discharge of 266 cubic feet per second (c.f.s.).
- 1.3.3 Dam and Reservoir Data: Pertinent data on the dam and reservoir are provided in the following table:

TABLE 1.1 DAM AND RESERVOIR DATA

Item	Elevation (feet T.B.M.)	Area (acres)	Reservoir Capacity		Length (feet)
			Acre- feet	Watershed (inches)	
Top of Dam (minimum)	1002.2	23.6	109	0.76	2500
Spillway Crest (Normal Pool)	1000.0	17.5	64	0.45	2120
Streambed at downstream toe of dam	988.0	-	-	-	-

NAME OF DAM: GAINES MILL DAM

## SECTION 2 - ENGINEERING DATA

- 2.1 Design: Design plans, specifications and boring logs were not available for use in preparing this report. No stability analyses or hydrologic and hydraulic data were available for review.
- 2.2 Construction: Construction records, as-built plans and inspection logs were not available for review.
- 2.3 Evaluation: No construction records or as-built plans were available to adequately assess the condition of the dam. All evaluations and assessments in this report were based upon field observations, discussions with the owner and office analyses.

NAME OF DAM: GAINES MILL DAM

## SECTION 3 - VISUAL INSPECTION

### 3.1 Findings

3.1.1 General: The field inspection was conducted on 16 January 1981. At the time of the inspection, the pool elevation was 1000.1 feet T.B.M., the tailwater elevation was 988.5 feet T.B.M., and the weather was overcast with the temperature at 40 degrees Fahrenheit. The ground surfaces of the embankment and abutments were frozen with scattered patches of snow. The dam and appurtenant structures were found to be in generally fair overall condition at the time of the inspection. Deficiencies found during the inspection will require remedial treatment. The following are brief summaries of deficiencies found during the inspection. A field sketch of conditions found during the inspection is presented as Plate 1 in Appendix I. The complete visual inspection check list is included as Appendix III. No record of any previous inspections was found.

3.1.2 Dam: The embankment was found to be in generally fair condition. No surface cracks or unusual movement or cracking at or beyond the toe were observed. The downstream face of the dam is hummocky with slopes varying from 1.9H to 1.4H:1V. Sloughing and erosion are evident on the downstream slope near the right end of the dam. The upstream face of the dam is also hummocky with small brush present and evidence of slight wave erosion. An eroded area, approximately two feet wide and two feet long and sloping into the reservoir, was observed on the upstream face about 100 feet left of the spillway. A small gully, about 0.5 feet deep and extending from the crest to the reservoir, was observed on the upstream face about 10 feet left of the spillway. The crest of the dam has a straight horizontal alignment except for a slight designed curvature at the right abutment. The vertical alignment of the dam varies about 1.0 foot. Settlement of about one foot was observed along the left abutment where the 18-inch CMP crosses the dam. There

NAME OF DAM: GAINES MILL DAM

are many large oak trees, some up to three feet in diameter, and thick brush on the downstream slope, but very little grass cover under the leaves and dead vegetation (Photo 5). The crest of the dam is vegetated with grass except for the area immediately adjacent to the spillway where several large trees and low brush are growing. There is no riprap on the dam. Near the right abutment, a gully, about 4 feet deep and 40 feet long and containing a small clear seep, runs diagonally across the downstream face to the spillway discharge channel (Photo 6). There is some erosion and several fallen trees at this point. Several soggy areas containing small puddles were observed at the toe of the embankment. There are two large ponded areas at the toe near the right end of the dam, with the largest of these being connected to the discharge channel (Photo 7). Both areas were ice-covered and it is believed that the seepage was diffuse. No evidence of an internal drainage system was found during the inspection.

3.1.3

Appurtenant Structures: The approach channel to the spillway from the reservoir is silted with sediment and leaves but there are no major obstructions. There are no major cracks in the spillway; however, small surface cracks and slight spalling was observed. The concrete spillway appears to be basically solid. There is about 0.5 feet of erosion from underneath the toe of the spillway. The retaining walls at each end of the spillway are undercut and the concrete eroded at the outfall end (Photo 1), but both are basically sound. Immediately downstream of the spillway, water in the discharge channel flows into a small pool about 3 feet deep, obstructed by a small protrusion of land and a large dying tree (Photo 8). Below this point, water in the discharge channel flows through an eroded channel 5 feet deep and 15 feet wide for about 150 feet to a large pool with eroded banks and then into the downstream channel. The old mill raceway, located at the left abutment downstream of the dam, contains an 18-inch CMP. It appears that this pipe runs through the dam; however, the inlet is either

NAME OF DAM: GAINES MILL DAM

absent or submerged. An old gate at the crest of the dam was apparently used to control the flow of water into this pipe. The exposed pipe is broken in several places and the control gate appears to be inoperable. Both the raceway and the pipeline appear to have been abandoned. No evidence of a drain pipe or any other discharge conduit was found.

3.1.4 Reservoir Area: The area adjacent to the reservoir is moderately sloping and heavily wooded, with no signs of excessive erosion or sloughing. Some sedimentation was observed at the spillway entrance. The extent of sedimentation within the reservoir was not directly observed; however, it is not expected to be significant. The reservoir was determined to be 11.0 feet deep at a point 40 feet upstream of the embankment.

3.1.5 Downstream Channel: The downstream channel has a low gradient, approximately 0.3 percent, and is heavily wooded. About 500 feet downstream from the dam, Powhite Creek flows under VA Route 156 through two box culverts, each 5.5 feet deep and 10.0 feet wide. The road level above these culverts is about 2 feet higher than the crest of the dam. Below VA Route 156, the channel is about 400 feet wide and heavily wooded.

3.1.6 Instrumentation: There is no instrumentation at the dam site.

3.2 Evaluation: In general, the dam and appurtenant structures are in fair condition. Brush and trees should be removed from the embankment by cutting them off at ground level. Trees with a trunk diameter greater than 3 inches should also have their root systems removed. The resultant holes should then be backfilled, compacted and seeded. The low area in the crest near the left abutment is not considered to be significant enough at this time to warrant repairs. On the upstream embankment, areas of erosion should be backfilled, compacted and seeded. The seep in the gully on the downstream embankment is clear with no evidence of piping and is not considered serious. The gully, soggy areas near the toe, and the two large ponded areas at

NAME OF DAM: GAINES MILL DAM

the toe near the right end of the dam should be back-filled, compacted and seeded. The portions of the retaining walls that have been undercut and eroded should be repaired and anchored to prevent undercutting from reoccurring. The discharge channel immediately downstream of the spillway should be cleared of fallen trees, sediment and other debris now blocking the channel. A staff gage should be installed to monitor reservoir levels above normal pool.

There are several items which do not require immediate remedial measures, but should be closely monitored in order to avoid problems in the future. The concrete spillway is basically sound but small surface cracks and spalling of the concrete and erosion at the base of the spillway were observed. Erosion along the discharge channel is occurring but, in its present location, does not have a detrimental effect on the dam. The soggy areas and areas where water has ponded near the downstream toe of the embankment were ice-covered and the presence of active seepage could not be determined; however, none of the areas where seepage is suspected or was observed are considered to be serious at the present time.

NAME OF DAM: GAINES MILL DAM

#### SECTION 4 - OPERATIONAL PROCEDURES

- 4.1 Procedures: The operation of the dam is an automatic function controlled by the crest of the spillway at elevation 1000.0 feet T.B.M.
- 4.2 Maintenance of Dam: Maintenance of the dam is the responsibility of the owner. An inspection or maintenance schedule has not been instituted.
- 4.3 Maintenance of Operating Facilities: No operating facilities were observed at the dam at the time of the inspection.
- 4.4 Warning System: At the time of inspection, there was no warning system or emergency action plan in operation.
- 4.5 Evaluation: Past maintenance of the dam has been inadequate. Regular inspections should be made of the dam and appurtenant structures. A thorough check list should be compiled by the owner's representative as a guide for the inspections. Maintenance items should be corrected annually. A warning system and emergency action plan should be developed and put into operation.

NAME OF DAM: GAINES MILL DAM

## SECTION 5 - HYDRAULIC/HYDROLOGIC DATA

- 5.1 Design: No design data were available for use in preparing this report.
- 5.2 Hydrologic Information: No rainfall, stream gage or reservoir stage records are maintained for this dam.
- 5.3 Flood Experience: No records were available.
- 5.4 Flood Potential: The Probable Maximum Flood (PMF) and 1/2 Probable Maximum Flood (1/2 PMF) were developed and routed through the reservoir by use of the HEC-1 DB computer program (Reference 9, Appendix IV) and appropriate unit hydrograph, precipitation and storage-outflow data. Clark's  $T_c$  and R coefficients for the local drainage areas were estimated from basin characteristics. The rainfall applied to the unit hydrograph was taken from a publication by the National Oceanic and Atmospheric Administration (Reference 17, Appendix IV). Rainfall losses for the PMF and 1/2 PMF were estimated at an initial loss of 1.0 inches and a constant loss rate of 0.05 inches per hour thereafter.
- 5.5 Reservoir Regulation: Pertinent dam and reservoir data are provided in Table 1.1, Paragraph 1.3.3.

Regulation of flow from the reservoir is automatic. Normal flows are maintained by the crest of the principal spillway at elevation 1000.0 feet T.B.M.

The outlet discharge capacity was computed by hand; reservoir area was planimetered from the Seven Pines, Virginia, 7.5 minute USGS quadrangle; and storage capacity was computed by the HEC-1 DB program. All flood routings were begun with the reservoir at normal pool. Outlet discharge capacity and storage capacity curves were computed to elevations above the crest of the dam.

- 5.6 Overtopping Potential: The probable rise of the reservoir and other pertinent information on reservoir performance are shown on the following table:

NAME OF DAM: GAINES MILL DAM

TABLE 5.1 RESERVOIR PERFORMANCE

Item	Normal <sup>1</sup>	Hydrographs	
		1/2 PMF	PMF <sup>2</sup>
Peak flow, c.f.s.			
Inflow	0.5	7,299	14,598
Outflow	0.5	7,245	14,517
Peak elev., ft. T.B.M.	1000.1	1005.8	1007.6
Non-overflow section <sup>3</sup> (elev. 1002.2 ft. T.B.M.)			
Depth of flow, ft.	-	3.6	5.4
Average velocity, f.p.s.	-	8.8	10.8
Total duration of over- topping, hrs.	-	21.7	27.1
Tailwater elev., ft. T.B.M.	988.5	-	-

<sup>1</sup>Conditions at time of inspection.

<sup>2</sup>The PMF is an estimate of flood discharges that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in a region.

<sup>3</sup>Velocity estimates were based on critical depth at control section.

5.7 Reservoir Emptying Potential: There are no facilities for draining the reservoir.

5.8 Evaluation: Gaines Mill Dam is a "small" size - "high" hazard dam requiring evaluation for a spillway design flood (SDF) in the range between the 1/2 PMF and the PMF. Due to the risk involved, the 1/2 PMF has been selected as the SDF. The SDF was routed through the reservoir and found to overtop the dam by a maximum depth of 3.6 feet with an average critical velocity of 8.8 feet per second (f.p.s.). Total duration of the dam overtopping will be 21.7 hours. The spillway is capable of passing up to 7 percent of the PMF or 14 percent of the SDF without overtopping the dam.

Conclusions pertain to present conditions and the effect of future development on the hydrology has not been considered.

NAME OF DAM: GAINES MILL DAM

## SECTION 6 - DAM STABILITY

6.1 Foundation and Abutments: The dam is located in the Atlantic Coastal Plain physiographic province of Virginia, which is characterized by low relief and low elevations. The area is underlain by generally unconsolidated marine and fluvial sediments of Cretaceous to Recent geologic age. The area of the dam is underlain by the Tertiary-age Calvert formation. This unit typically consists of unconsolidated sandy clay and fine-grained sand. Exposed soils in the banks of the spillway discharge channel were observed to consist of brown sandy clay. No previous information describing local subsurface conditions was available for the visual inspection or subsequent analyses. It is not known how the dam was keyed into the foundation or abutments.

### 6.2 Embankment

6.2.1 Materials: Information describing the nature of the embankment materials or any zoning within the dam was not available for this investigation. During the visual inspection, the outer embankment materials were noted as consisting of brown sandy clay. No obvious sources of borrow were discovered in the immediate area of the dam.

6.2.2 Stability: Design plans and the results of a previous stability analysis were not available for use during this evaluation. The embankment is assumed to be a homogeneous type. The dam is 14.2 feet high with a crest width of 12 feet. The upstream embankment was observed to slope about 2.5H:1V. The downstream slope ranged from 1.4H:1V to 1.9H:1V. No facilities exist for draining the reservoir in the event of an emergency, and the embankment is not subject to rapid drawdown. The embankment soils are considered to be of the CL or ML type (clay or silt of low to moderate plasticity) according to the USCS soil classification system.

According to guidelines outlined in Design of Small Dams by the U.S. Department of the Interior, Bureau of Reclamation, the upstream

NAME OF DAM: GAINES MILL DAM

slope of a small homogeneous dam constructed of CL or ML soils with a stable foundation should be 3.0H:1V if not subject to rapid drawdown. The recommended downstream slope is 2.5H:1V. A crest width of 13 feet is recommended, based on the height of the dam. Based on these guidelines, the crest width and embankment slopes are inadequate.

Tension cracks or unusual alignment of the crest were not observed during the visual inspection. However, an area of the downstream face near the right abutment has appeared to have experienced moderate sloughing and erosion, resulting in the formation of steeper slopes than observed elsewhere on the embankment. Minor erosion was observed on the upstream face just above the pool elevation at the time of inspection. The downstream face was generally covered with brush and large trees up to about 3 feet in diameter. No seepage was observed on the embankment, but two areas of possible seepage were found near the toe on the right side of the dam and a small clear seep was found in a gully on the right downstream abutment. The two areas at the toe were frozen and were not flowing at the time of inspection.

6.2.3 Seismic Stability: The dam is located in Seismic Zone 1, which presents no hazard from earthquakes, according to the Recommended Guidelines for Safety Inspection of Dams by the Department of the Army, Office of the Chief of Engineers. This determination is contingent on the requirements that static stability conditions are satisfactory and conventional safety margins exist.

6.3 Evaluation: The results of a previous stability analysis were not available for review as part of this evaluation. The upstream and downstream slopes of the dam are steeper than recommended in the Bureau of Reclamation guidelines, and the crest width is slightly more narrow than recommended. However, signs of potential instability were absent during the visual inspection and a stability check is not required. Further attention should be given to the areas of possible seepage at the toe and the small clear seep at the

NAME OF DAM: GAINES MILL DAM

right abutment. It is recommended that these areas be visually inspected during all periods of high reservoir levels to determine any turbidity and/or any increase in the rate of seepage. If turbidity and/or change of rate develops, the services of a qualified geotechnical firm should be immediately retained to perform a stability check of the dam.

As discussed in Section 5 of this report, the dam would be overtopped by the SDF. The SDF would overtop the dam by a maximum depth of 3.6 feet with an average critical velocity of 8.8 feet per second (f.p.s.). Total duration of the overtopping would be 21.7 hours. Because the maximum depth and the duration of overtopping are substantial, and because the average critical velocity exceeds the effective eroding velocity for a vegetated earth embankment of 6.0 f.p.s., the potential overtopping flows are considered detrimental to the embankment.

NAME OF DAM: GAINES MILL DAM

## SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

- 7.1 Dam Assessment: No construction plans, design specifications, as-built plans or any other engineering data for the dam were available for use in preparing this report. The dam and appurtenant structures were found to be in good overall condition at the time of the inspection. Deficiencies discovered during the field inspection and office analyses will require further investigation and remedial treatment. Maintenance of the dam is considered inadequate. Signs of instability were not observed and a stability check is not required.

Using the Corps of Engineers' screening criteria for initial review of spillway adequacy, the 1/2 PMF was selected as the SDF for the "small" size - "high" hazard classification of Gaines Mill Dam. The spillway is adjudged as seriously inadequate since dam failure from overtopping would significantly increase the hazard to loss of life downstream from the dam over that which would exist just before overtopping failure. The spillway is capable of passing up to 14 percent of the SDF or 7 percent of the PMF without overtopping the dam. Overtopping flows are considered to be detrimental to the embankment.

Due to the seriously inadequate spillway, the dam is assessed as unsafe, non-emergency. The classification of "unsafe" applied to a dam because of a seriously inadequate spillway is not meant to connote the same degree of emergency as would be associated with an unsafe classification applied for a structural deficiency. It does mean, however, based on an initial screening and preliminary computations, that there appears to be a serious deficiency in spillway capacity. If a severe storm were to occur, overtopping and failure of the dam would take place, significantly increasing the hazard to loss of life downstream from the dam.

The upstream and downstream slopes and part of the crest are covered with large trees and brush. There are erosion problems on the upstream slope and on the right side of the downstream slope. Several wet areas and areas of ponded water are located near the toe of the downstream embankment. A small seep was observed in the gully in the downstream slope near the spillway. Minor erosion and signs of deterioration are present at the concrete spillway. Debris and erosion are present in the discharge channel.

NAME OF DAM: GAINES MILL DAM

There is no warning system or emergency action plan currently in operation.

- 7.2 Recommended Remedial Measures: It is recommended that, within two months of the date of notification of the Governor of the Commonwealth of Virginia, the owner engage the services of a professional engineering consultant to perform a detailed hydrologic/hydraulic study to evaluate spillway capacity.

Within six months of the notification of the Governor, the consultant's report of appropriate remedial measures should have been completed and the owner should have an agreement with the Commonwealth of Virginia for a reasonable time frame in which all remedial measures will be complete.

The seep in the gully, as well as the wet and ponded areas near the toe of the embankment, should be examined at regular intervals and after periods of heavy rains for any signs of increased flood or turbidity, which may indicate the potential for piping of embankment material. If increased flow or turbidity is noted, a qualified geotechnical engineering firm should be retained to perform a stability check of the dam.

The condition of the concrete in the spillway and the erosion at the toe of the spillway and in the discharge channel should be closely monitored. These items are currently assessed as having no detrimental effect on the dam, but should conditions change in the future, remedial measures may become necessary.

Regular inspections should be made of the dam and appurtenant structures. A thorough check list should be compiled for use by the owner's representative as a guide for the inspections. Maintenance items should be completed annually.

A formal warning system and emergency action plan should be developed and put into effect as soon as possible.

The following repair items should be accomplished as part of the general maintenance of the dam:

- 1) Cut brush and trees on the embankment at ground level and remove the root systems of trees with a trunk diameter greater than 3 inches. The resultant holes should then be backfilled, compacted and seeded.

NAME OF DAM: GAINES MILL DAM

- 2) On the upstream face, backfill, compact, and seed the two eroded areas left of the spillway.
- 3) On the downstream face, backfill, compact, and seed the gully across the right side of the slope to the discharge channel, and the soggy areas and ponded areas near the toe of the embankment.
- 4) Repair the eroded concrete on the spillway retaining walls.
- 5) Clear the discharge channel of sediment, fallen trees and other debris.
- 6) Install a staff gage to monitor reservoir levels above normal pool.

NAME OF DAM: GAINES MILL DAM

APPENDIX I

PLATES

## CONTENTS

Location Plan

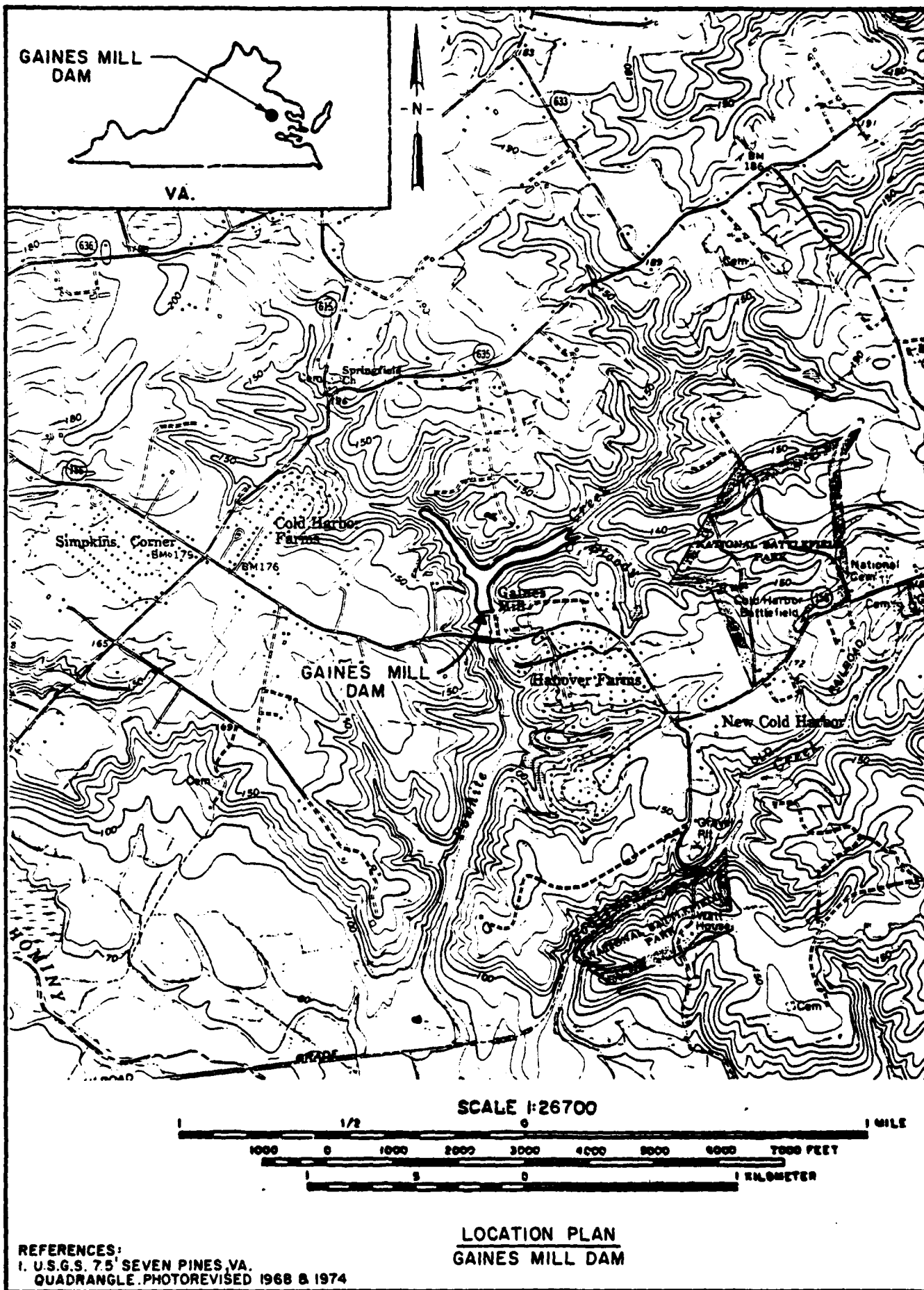
Plate 1: Field Sketch

Plate 2: Top of Dam Profile

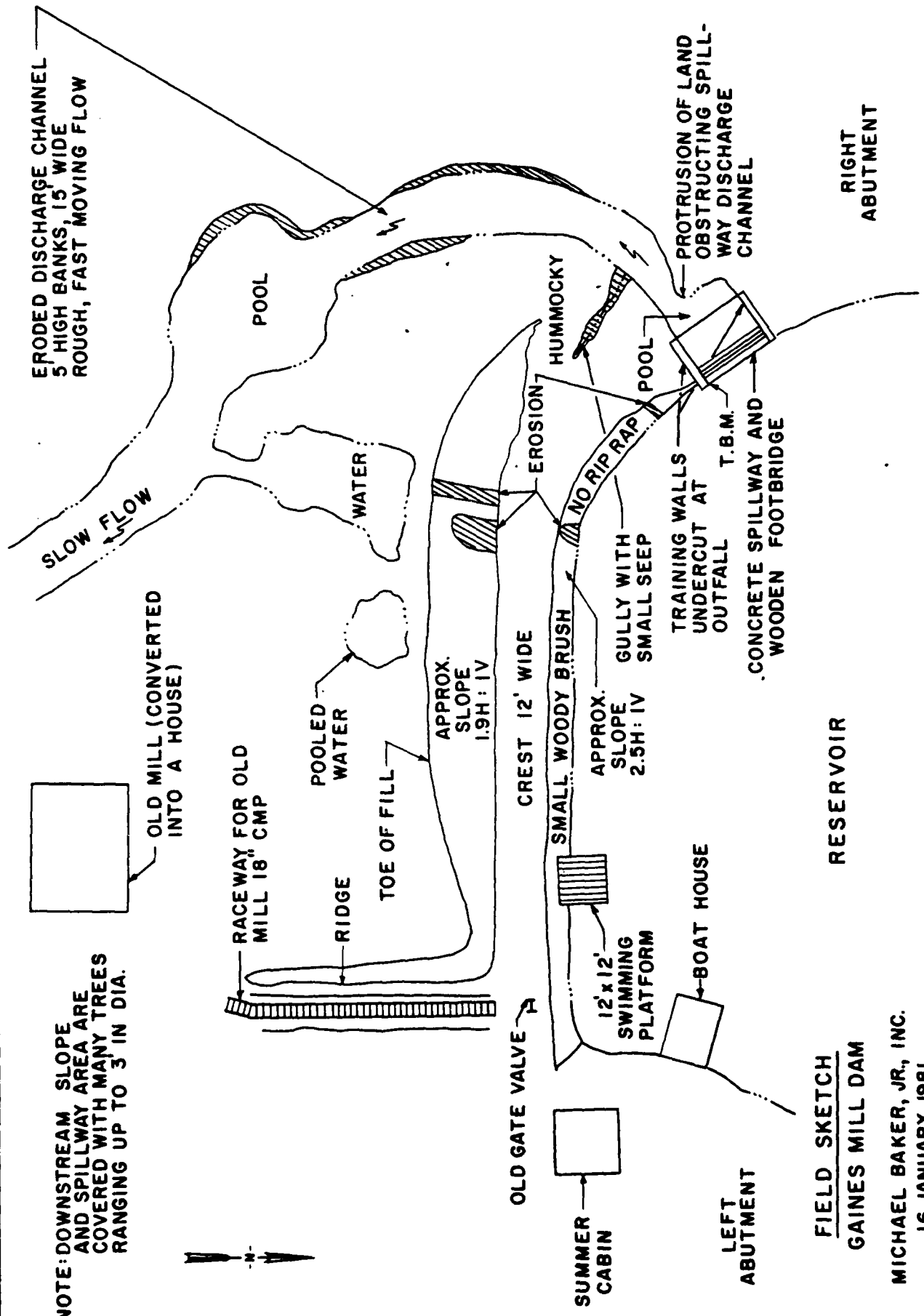
Plate 3: Typical Cross Sections

NAME OF DAM: GAINES MILL DAM

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NOTE: DOWNSTREAM SLOPE AND SPILLWAY AREA ARE COVERED WITH MANY TREES RANGING UP TO 3 IN DIA.



FIELD SKETCH  
GAINES MILL DAM

MICHAEL BAKER, JR., INC.  
16 JANUARY 1981  
PLATE 1

NO SCALE

MICHAEL BAKER, JR., INC.  
THE BAKER ENGINEERS

Box 280  
Beaver, Pa. 15009

Subject VIRGINIA DAMS

S.O. No. \_\_\_\_\_

Gaines Mill Dam

Sheet No. \_\_\_\_\_ of \_\_\_\_\_

Top-of-Dam Profile

Drawing No. \_\_\_\_\_

Computed by \_\_\_\_\_ Checked by \_\_\_\_\_ Date \_\_\_\_\_

# TOP OF DAM PROFILE LOOKING DOWNSTREAM

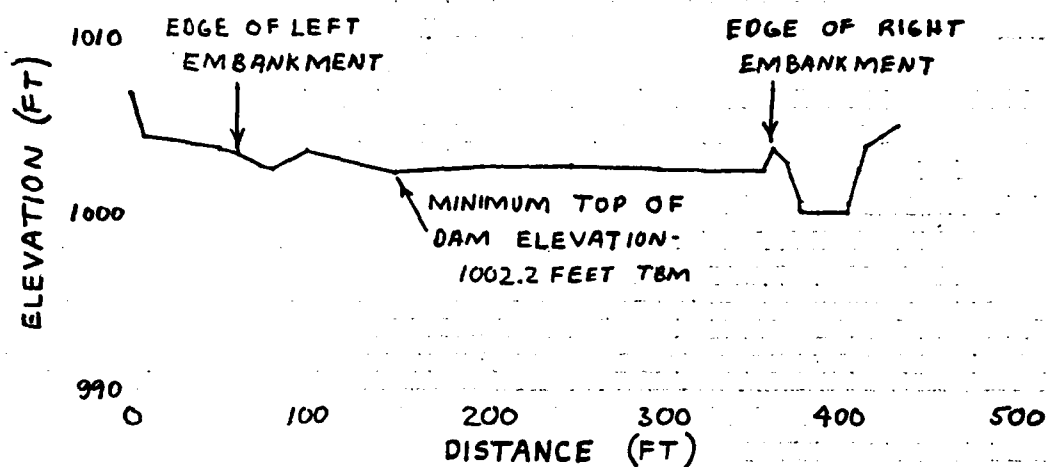


PLATE 2

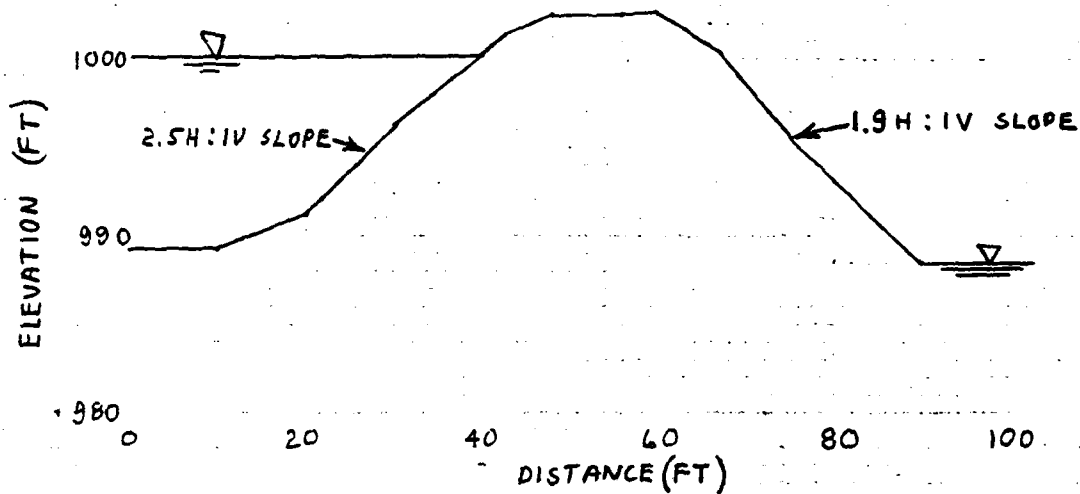
MICHAEL BAKER, JR., INC.  
THE BAKER ENGINEERS

Box 280  
Beaver, Pa. 15009

Subject VIRGINIA Dams S.O. No. \_\_\_\_\_  
Gaines Mill Dam Sheet No. \_\_\_\_\_ of \_\_\_\_\_  
Drawing No. \_\_\_\_\_  
Computed by \_\_\_\_\_ Checked by \_\_\_\_\_ Date \_\_\_\_\_

DAM CROSS SECTION STA. 2+25

WIDTH OF CREST = 12 FEET



DAM CROSS SECTION STA 3+00

WIDTH OF CREST = 10 FEET

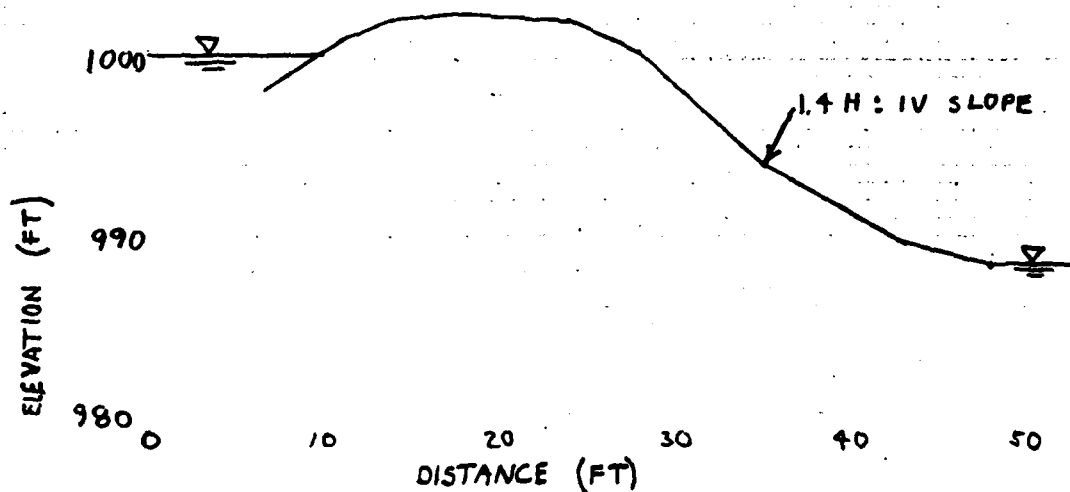


PLATE 3

APPENDIX II

PHOTOGRAPHS

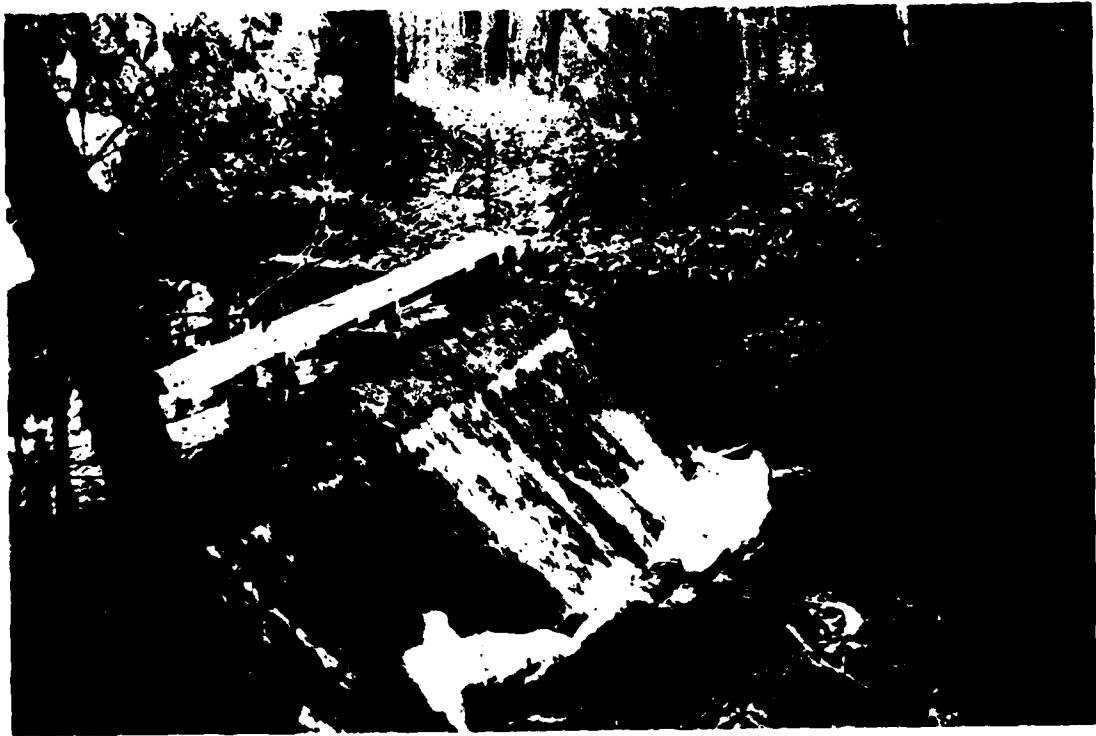
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- Photo 1: Concrete Spillway and Retaining Walls
- Photo 2: Downstream End of Spillway Discharge Channel
- Photo 3: Abandoned Mill Raceway and 18-inch Corrugated Metal Pipe
- Photo 4: Culverts Under VA Route 156
- Photo 5: Vegetation on Downstream Embankment
- Photo 6: Gully Containing Small Seep on Downstream Embankment
- Photo 7: Ponded Area at Toe of Downstream Embankment
- Photo 8: Obstructions in Discharge Channel Downstream of Spillway

Note: Photographs were taken on 16 January 1981.

NAME OF DAM: GAINES MILL DAM

# **GAINES MILL DAM**



**PHOTO 1. Concrete Spillway and Retaining Walls**



**PHOTO 2. Downstream End of Spillway Discharge Channel**

# **GAINES MILL DAM**



**PHOTO 3. Abandoned Mill Raceway and 18 Inch Corrugated Metal Pipe**



**PHOTO 4. Culverts Under VA Route 186**

**GAINES MILL DAM**



**PHOTO 5. Vegetation on Downstream Embankment**



**PHOTO 6. Gully Containing Small Seep on Downstream Embankment**

## **GAINES MILL DAM**



**PHOTO 7. Ponded Area at Toe of Downstream Embankment**



**PHOTO 8. Obstructions in Discharge Channel Downstream of Spillway**

APPENDIX III  
VISUAL INSPECTION CHECK LIST

Check List  
Visual Inspection  
Phase 1

Name of Dam Gaines Mill Dam County Hanover State Virginia Coordinates Lat. 3735.3  
Long. 7718.3

Date of Inspection 16 January 1981 Weather Partly cloudy, cold Temperature 40° F.

1111

Pool Elevation at Time of Inspection 1000.1 ft. T.B.M.\* Tailwater at Time of Inspection 988.4 ft. T.B.M.\*  
\*All elevations are referenced to a Temporary Bench Mark (T.B.M.) with an assumed elevation of 1000.00 ft. This T.B.M. was located at the crest of the spillway.

Inspection Personnel:

Michael Baker, Jr., Inc.:

Stephen Shoemaker  
Anthony Klimek  
David Meredith

Owner's Representatives:

Mr. Ted Hanson

Virginia State Water Control Board:

Edwin B. Constantine, III  
Leon Musselwhite

Stephen Shoemaker Recorder

# EMBANKMENT

Name of Dam GAINES MILL DAM

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None observed	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	<p>The downstream face of the dam is hummocky and slopes vary from 1.9H:1V to 1.4H:1V. Sloughing and erosion are evident on the downstream slope near the right end of the dam. The upstream face of the dam is also hummocky with evidence of slight wave erosion. An eroded area, approximately 2 ft. wide, 2 ft. long and sloping into the reservoir was observed on the upstream face about 100 ft. left of the spillway. A small gully, about 0.5 ft. deep and extending from the crest to the reservoir, was observed on the upstream face about 10 ft. left of the spillway. On the downstream face near the right abutment, a gully, about 4 ft. deep and 40 ft. long, runs diagonally across the face to the spillway discharge channel.</p>	<p>The areas of erosion on the upstream face and the gully on the downstream face should be backfilled, compacted and seeded.</p>

# EMBANKMENT

Name of Dam GAINES MILL DAM

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	The crest is about 12 ft. wide and has a straight horizontal alignment except for a slight designed curvature at the right abutment. The vertical alignment varies about 1.0 ft. Settlement of about 1 ft. was observed over the 18 in. corrugated metal pipe near the left abutment of the dam.	The low area near the left abutment is not considered to be significant enough at this time to warrant repairs.
RIPRAP FAILURES	There is no riprap on the dam.	
EMBANKMENT MATERIALS	The outer embankment materials consisted of brown sandy clay. The ground surfaces of the embankment and abutments were frozen with scattered patches of snow.	
VEGETATION	There are many large oak trees, some up to 3 ft. in diameter, and thick brush on the embankment slopes, but very little grass cover under the leaves and dead vegetation. The crest of the dam is vegetated with grass except for the area immediately adjacent to the spillway where several large trees and low brush are growing.	Brush and trees should be removed from the embankment by cutting them off at ground level. Trees with a trunk diameter greater than 3 in. should also have their root systems removed. The resultant holes should be backfilled, compacted and seeded.

# EMBANKMENT

Name of Dam GAINES MILL DAM

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	<p>The spillway cuts through the natural ground on the wooded, right abutment. An old abandoned mill race, 10 ft. wide and 5 ft. deep, is located along the left abutment downstream of the dam. An 18 in. corrugated metal pipe (CMP) is lying in the mill race and an old control valve is located on the left side of the embankment crest. It appears the pipe runs through the dam but the inlet is either absent or submerged. The exposed pipe is broken in several places and the control gate appears to be inoperable. No erosion or sloughing was observed near the abutments.</p>	<p>Both the raceway and pipe-line appear to have been abandoned.</p>
ANY NOTICEABLE SEEPAGE	<p>A small, clear seep was observed in the gully on the right side of the downstream embankment. Several soggy areas containing puddles were observed at the toe of the embankment. There are 2 large ponded areas at the toe near the right end of the dam with the largest of these being connected to the discharge channel. Both areas were iced over and presence of active seepage could not be determined.</p>	<p>Backfill, compact, and seed the gully, the soggy areas, and the ponded areas.</p>
STAFF GAGE AND RECORDER	<p>None observed</p>	<p>A staff gage should be installed to monitor reservoir levels above normal pool.</p>
DRAINS	<p>No evidence of an internal drainage system was found during inspection.</p>	

# UNGATED SPILLWAY

Name of Dam: GAINES MILL DAM

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	<p>The cast-in-place concrete spillway is approximately 26 ft. long (measured perpendicular to flow). The weir has a 2 ft. wide level crest and a downstream face that drops about 4.5 ft. at a 45° slope. There are no major cracks on the spillway; however, small surface cracks and minor spalling were observed. There is about one-half foot of erosion from beneath the toe of the spillway. There is a short retaining wall at each end of the concrete spillway. Both are undercut and the concrete eroded at the outfall end.</p>	<p>The concrete spillway appears to be basically solid. The small surface cracks and spalling in the concrete and erosion under the spillway toe are not significant enough to warrant repairs at this time, but their condition should be closely monitored during future inspections. The portions of the retaining walls that have been undercut and eroded should be repaired and anchored to prevent undercutting from reoccurring.</p>

## APPROACH CHANNEL

The approach channel to the spillway from the reservoir is about 10 ft. long and 30 ft. wide. It is silted with sediment and leaves, but there are no major obstructions.

## DISCHARGE CHANNEL

The concrete spillway flows into a small pooled area which is about 3 ft. deep. There is a small protrusion of land with a large dying tree obstructing the immediate channel. The discharge channel is bound by eroded 5 ft. high banks. The channel circles 150 ft. downstream, discharging into a large pool with eroded banks.

The small protrusion of land and dying tree which are obstructing the channel should be removed.

Name of Dam: GAINES MILL DAMIII-6

# INSTRUMENTATION

Name of Dam: GAINES MILL DAM

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
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MONUMENTATION/SURVEYS	None observed	
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OBSERVATION WELLS	None	
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WEIRS	None	
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PIEZOMETERS	None	
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OTHER	None	
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# RESERVOIR

Name of Dam: GAINES MILL DAM

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	The area adjacent to the reservoir is moderately sloping and heavily wooded. There are no signs of excessive erosion or sloughing.	
SEDIMENTATION	It was observed that silt has built up at the spillway entrance. The extent of sedimentation within the reservoir was not directly observed; however, it is not expected to be significant. The reservoir was determined to be 11.0 ft. deep at a distance of 40 ft. from the upstream face of the dam.	
OTHER	According to the owner, the dam was intentionally breached and rebuilt in 1926.	

# DOWNSTREAM CHANNEL

Name of Dam: GAINES MILL DAM

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	The downstream channel has a low gradient and is heavily wooded. About 500 ft. downstream from the dam, the stream flows beneath VA Route 156. At this point, the stream flows through two box culverts, each 5 ft. 6 in. deep and 10 ft. wide. It appears that the road embankment is 2 ft. higher than the crest of the dam.	In the event of failure, the flood wave is not likely to move past VA Route 156.
SLOPES	The downstream channel has a low gradient, and it is about 400 ft. wide.	
APPROXIMATE NO. OF HOMES AND POPULATION	There is one occupied house located within the downstream channel about 300 ft. from the dam.	Loss of life is considered possible should the dam fail.

APPENDIX IV  
GENERAL REFERENCES

## GENERAL REFERENCES

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